

CLAIMS:

1. A tip device having at least a portion thereof with an outer surface bound to a layer of a material comprising nanoparticles, the nanoparticles acting as
5 active media with respect to electromagnetic radiation.
2. The device according to Claim 1, wherein said at least portion of the device is made of a material selected from insulator-, semiconductor- or conductor-based material.
3. The device according to Claim 1 or 2, wherein the thickness of the
10 nanoparticles-containing layer is from sub-monolayer to multiple layers.
4. The device of Claim 3, wherein the nanoparticles are bound to said outer surface either directly or through a linker molecule.
5. The device according to any one of preceding Claims, wherein the nanoparticles are made of semiconductor, metal or oxide materials.
- 15 6. The device according to Claim 5, wherein said nanoparticles are nanocrystals with a variety of shapes selected from spherical or nearly spherical, rod, branched shape, wire, tube or core-shell layered structures of these shapes.
7. The device according to Claim 5 or 6, wherein said nanoparticles are made of a material comprising CdSe/ZnS, InAs, InP, GaP, GaAs, InSb, GaSb,
20 GaN, Si, Ge, CdTe, CdSe, ZnSe, ZnO, Au, Ag, Pt, Ni, Pd, In, Bi or mixtures thereof.
8. A method of forming a tip device having at least a portion thereof operable as active media with respect to electromagnetic radiation, the method comprising reacting a nanoparticles solution, powder or film with at least a
25 portion of a tip so as to bind a layer of nanoparticles to an outer surface of said at least portion of the tip, said nanoparticles acting as the active media with respect to electromagnetic radiation.
9. The method according to Claim 8, wherein said tip device is made of or coated by a material selected from Si, Au, Ag, Pt, Ti, Co, Cr, Ir, combinations of
30 these metals, Si₃N₄, TiN, glass, diamond and carbon.

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10. The method according to Claim 8 or 9, comprising activating said at least portion of the tip before reacting the nanoparticles solution with said at least portion of the tip.
11. The method according to any one of Claims 8 to 10, wherein said tip is
5 made of a material selected from insulator-, semiconductor- or conductor-based material.
12. The method according to any one of Claims 8 to 11, wherein the thickness of the nanoparticles-containing layer bound to the outer surface of the tip is from sub-monolayer thickness to multiple layers thickness.
- 10 13. The method of any one of Claims 8 to 12, comprising reacting said at least portion of the tip with linker molecules so as to obtain a tip having at least a portion thereof bound to the linker molecules, and carrying out said reacting of said at least portion of the so-obtained tip with the nanoparticles solution.
14. The method according to Claim 13, wherein said linker molecules are
15 organic molecules bearing at least two functional groups, one of the functional groups being capable to react and bind to the tips' surface and another of the functional groups being capable to react and bind to the nanoparticles.
15. The method according to Claim 13 or 14, comprising providing a tip device made from Si, SiO₂, glass, titanium oxide, TiN or Si₃N₄, silanizing at least
20 portion of the tip with an organosilane compound either in solution or in gas phase to form tip with at least a silanized portion and exposing the resulting tip to a solution, powder or film comprising nanoparticles to form the tip having at least portion thereof with the outer surface bound to the layer of nanoparticles, the nanoparticles-containing layer having a thickness selected from sub-
25 monolayer, monolayer and multiple layers.
16. An optical apparatus for use in analyzing a sample, the apparatus comprising at least one tip device configured according to any one of claims 1 to 7.
17. The apparatus according to Claim 16, comprising a light source
30 assembly, which comprises a pumping source operable to generate excitation

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radiation and said at least one tip device, which when pumped emits exciting energy to irradiate a sample and thus cause a radiation response of the sample.

18. The apparatus according to Claim 16, comprising a light source assembly, which comprises a pumping source and said at least one tip device, the
5 tip device when pumped by exciting radiation absorbs the exciting energy and transfers this energy, by a dipolar mechanism or by direct emission of a photon, to irradiate a sample and thus cause a sample response thereto.

19. The apparatus according to Claim 16, comprising a light source assembly and a detection assembly, the detection assembly comprising said at least one tip
10 device, which when excited by energy coming from a sample, generates a radiation response indicative of the sample excitation.

20. The apparatus according to Claim 16, comprising a light source assembly and a detection assembly, the detection assembly comprising said at least one tip device, the tip device, when being excited by energy coming from a sample,
15 either directly by absorption or by a dipolar energy transfer mechanism, generates a radiation response indicative of the sample excitation.

21. The apparatus of any one of Claims 16 to 20, configured and operable as a FRET-based microscope.

22. The apparatus of any one of Claims 16 to 20, configured and operable as a
20 light source.

23. The apparatus of any one of Claims 16 to 20, configured and operable as a Raman microscopy, said nanoparticles serving to locally enhance a Raman signal.

24. The apparatus of any one of Claims 16 to 20, configured and operable as
25 a second harmonic generation microscope, said nanoparticles serving to locally enhance a second harmonic signal.

25. The apparatus of any one of Claims 16 to 20, configured and operable as a non-linear optical microscope with the nanoparticles serving to locally enhance a signal.

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26. The apparatus of any one of Claims 16 to 20, configured and operable as a scanning probe microscope for topography imaging.

27. The apparatus of Claim 26, operable with at least one of the following modes: tapping mode, contact mode, electrical force microscopy, conductive
5 atomic force microscopy and force microscopy.

28. The apparatus of any one of Claims 16 to 20, configured and operable as a chemical force microscope.

29. A method for use in imaging a sample, the method comprising causing an energy interaction in a donor-acceptor pair formed by the tip of any one of
10 Claims 1-7 and the sample, and detecting a radiation response to said interaction indicative of sample' characteristics.

30. The method of Claim 29, wherein the radiation response includes radiation generated in the sample in response to exciting energy coming from the tip.

15 31. The method of Claim 29, wherein the radiation response includes radiation generated by the tip in response to exciting energy coming from the sample.

32. Use of the tip device as defined in any one of Claims 1 to 7 for FRET based microscopy.

20 33. Use of the tip device as defined in any one of Claims 1 to 7 as a light source.

34. Use of the tip device as defined in any one of Claims 1 to 7 for Raman microscopy, said nanoparticles serving to locally enhance a Raman signal.

35. Use of the tip device as defined in any one of Claims 1 to 7 for second
25 harmonic generation microscopy, said nanoparticles serving to locally enhance a second harmonic optical signal.

36. Use of the tip device as defined in Claim 6 for non-linear optical microscopy with the nanocrystals serving to locally enhance a signal.

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37. Use of the tip device as defined in Claim 6 for topography imaging in by scanning probe microscopy modes.
38. Use of the tip device of Claim 6 for chemical force microscopy imaging.